

CLAIMS

At least the following is claimed:

- 1 1. A method of ejecting a fluid, comprising the steps of:
2 heating the fluid to a lower threshold using electric heating;
3 heating the fluid to an upper threshold using laser energy; and
4 ejecting a volume of fluid after heating the fluid to the upper
5 threshold.
- 1 2. The method of claim 1, further comprising heating the fluid to the lower
2 threshold using electric heating immediately prior to heating the fluid to
3 the upper threshold.
- 1 3. The method of claim 1, further comprising:
2 heating the fluid in nozzle systems located in a first area of a
3 fluid ejection device to the lower threshold using an electric heating
4 layer located in the first area;
5 directing laser energy from a laser system at a photon absorbing
6 layer of selected nozzle systems in the first area; and
7 heating the fluid in the selected nozzle systems from the lower
8 threshold to the upper threshold using energy absorbed by the photon
9 absorbing layer.

1 4. The method of claim 3, further comprising:
2 heating the fluid in nozzle systems located in a second area to
3 the lower threshold using the electric heating layer located in the
4 second area;
5 directing laser energy from the laser system at a photon
6 absorbing layer of selected nozzle systems in the second area; and
7 heating the fluid in the selected nozzle systems from the lower
8 threshold to the upper threshold using energy absorbed by the photon
9 absorbing layer.

1 5. The method of claim 3, further comprising:
2 activating the electric heating layer in each area to heat the fluid
3 to the lower threshold in each area in a sequential manner from a first
4 end of the page-wide array to a second end of the page-wide array;
5 synchronizing the emission of laser energy from the laser
6 system with the activation of the electric heating layer;
7 scanning the laser from the first end to the second end of the
8 page-wide array as the fluid in each area is sequentially heated to the
9 lower threshold;
10 directing laser energy from the laser system at a photon
11 absorbing layer of a plurality of selected nozzle systems in each area;
12 heating the fluid in the selected nozzle systems sequentially to
13 the upper threshold as the laser scans across the page-wide array; and
14 ejecting a volume of fluid from the selected nozzle systems as
15 the laser scans across the page-wide array.

1 6. The method of claim 3, wherein the electric heating layer and the
2 photon absorbing layer comprise a same material.

1 7. The method of claim 3, wherein the electric heating layer and the
2 photon absorbing layer are distinct layers.

1 8. A method of ejecting fluid from a page-wide array comprising a laser
2 system operative to emit laser energy and a page-wide array comprising a
3 plurality of areas, each area includes a plurality of nozzle systems and a
4 heating layer, the heating layer includes an electric heating layer and a
5 photon absorbing layer, each nozzle system includes the fluid, comprising the
6 steps of:

7 heating the fluid in each area to a lower threshold using the
8 electric heating layer corresponding to each area in a sequential
9 manner from a first end of the page-wide array to a second end of the
10 page-wide array;

11 directing laser energy from the laser system at the photon
12 absorbing layer of a plurality of selected nozzle systems in each area
13 beginning from the first end of the page-wide array to the second end
14 of the page-wide array;

15 heating the fluid in the selected nozzle systems from the lower
16 threshold to an upper threshold using the laser system; and

17 ejecting a volume of the fluid from the selected nozzle systems
18 beginning from the first end of the page-wide array to the second end
19 of the page-wide array.

1 9. The method of claim 8, further comprising:

2 synchronizing the emission of laser energy from the laser
3 system with the activation of the electric heating layer.

- 1 10. A printhead, comprising:
2 a laser system operative to emit laser energy;
3 a page-wide array comprising a plurality of areas, each
4 area includes a heating layer and a plurality of nozzle systems,
5 the heating layer includes an electric heating layer and a photon
6 absorbing layer, each heating component of a particular area
7 overlaps the adjacent area, each nozzle system includes:
8 an orifice, a fluid chamber, and the photon
9 absorbing layer, the fluid chamber includes a fluid, a
10 portion of the electric heating layer is adjacent the fluid
11 chamber and is operative to heat the fluid in the fluid
12 chamber to the lower threshold temperature, the photon
13 absorbing layer is adjacent the fluid chamber, the photon
14 absorbing layer is operative to absorb laser energy
15 emitted from the laser and heat the fluid in the fluid
16 chamber from the lower threshold temperature to the
17 upper threshold temperature.
- 1 11. The printhead of claim 10, wherein a fluid ejection system is operative
2 to control the activation of the electric heating layers in a sequential
3 manner from the first end of the page-wide array to the second end of
4 the page-wide array, wherein the fluid ejection system is operative to
5 control the scan rate of the laser system from the first end of the page-
6 wide array to the second end of the page-wide array, wherein the
7 page-wide array printing system synchronizes the activation of the
8 electric heating layers and the scan rate of the laser system from the
9 first end to the second end so that the fluid in the fluid chamber of a
10 selected nozzle system is heated to the lower threshold temperature
11 using the electric heating layer prior to the laser emitting laser energy
12 directed to the photon absorbing layer of the selected nozzle systems.
- 1 12. The printhead of claim 10, wherein the page-wide array includes about
2 2000 to 8000 nozzle systems.

- 1 13. The printhead of claim 10, wherein the fluid includes black ink.
- 1 14. The printhead of claim 10, wherein the electric heating layer
2 includes a resistive layer.
- 1 15. A printhead comprising:
2 a fluid chamber;
3 a nozzle in fluid communication with the fluid chamber to allow
4 the fluid to be ejected from the fluid chamber;
5 means, responsive to an electric current, for heating the fluid in
6 the fluid chamber to a first threshold; and
7 means, responsive to optical energy, for heating the fluid in the
8 fluid chamber to a second threshold sufficient to eject ink from the fluid
9 chamber.
- 1 16. The printhead of claim 15, comprising a plurality of fluid chambers and
2 a plurality of nozzles associated with each fluid chamber, wherein the
3 means responsive to the electric current heats the fluid in the plurality
4 of fluid chambers and the means responsive to optical energy is
5 operative to heat fluid at each nozzle.
- 1 17. The printhead of claim 15, comprising means for synchronizing the
2 heating of the fluid in the fluid chambers to the lower threshold with the
3 heating of the fluid from the lower threshold to the upper threshold.

- 1 18. The printhead of claim 15, comprising means for synchronizing the
2 heating of the fluid in each fluid chamber in a sequential manner using
3 the means responsive to the electric current with the heating of the
4 fluid in each nozzle using the means responsive to the optical energy.
- 1 19. A printhead comprising:
2 a plurality of fluid chambers;
3 a plurality of nozzles, each associated with at least one of the
4 plurality of fluid chambers;
5 a plurality of resistors, each coupled to receive electric current
6 and corresponding to one of the plurality of fluid chambers; and
7 a plurality photon absorbing layers that generate heat in
8 response to optical energy, each photon absorbing layer being coupled
9 to the fluid chambers to eject fluid from the fluid chambers.
- 1 20. The printhead of claim 19, wherein the photon absorbing layer includes
2 a plurality of sections each associated with a single nozzle.
- 1 21. The printhead of claim 19, further comprising a laser system operative
2 to direct laser energy at each of the plurality of photon absorbing
3 layers.
- 1 22. The printhead of claim 19, further comprising a print control system
2 operative to synchronize the activation of the electric heating layers
3 and the scan rate of the laser system to eject fluid from the fluid
4 chambers.

- 1 23. The printhead of claim 19, wherein the plurality of resistors and
2 plurality photon absorbing layers are substantially coplanar with each
3 other.

- 1 24. The printhead of claim 19, wherein the plurality of resistors and
2 plurality photon absorbing layers each form distinct layers.

- 1 25. The printhead of claim 24, wherein the plurality of resistors are each
2 adjacent to one of the plurality of fluid chambers and wherein the
3 plurality of photon absorbing layers are separated from the fluid
4 ejection chambers by the plurality of resistors.